

Evaluation Report of NIH K-12 Program

Title: Evaluation Report for the NIH3 Module, *How Your Brain Understands What Your Ear Hears*

Date: 2001

Description:

This report evaluates one component within the NIH K-12 program, the NIH Curriculum Supplements. The NIH Curriculum Supplements are K-12 teacher's guides to two weeks' of lessons that explore the science behind current health topics. The modules are sent free of charge upon request to educators across the United States. Over 50,000 educators have one or more curriculum supplement.

This study specifically examines the results of the field tests conducted during the development of:

How Your Brain Understands What Your Ear Hears (Grades 7 – 8)

This study was designed to determine the effectiveness of the module as a supplementary addition in the K-12 science curriculum. The field test sites were selected from volunteers who were chosen to maximize inclusion of various races, ethnicities, and geographic regions. The evaluation consisted of a field test with close-to-complete instructional materials. The surveys measured student knowledge using a pre/post test. The teachers also commented on the effectiveness of the lessons and their implementation. These results were used to identify strengths that were highlighted and weaknesses that were corrected in the final draft. The teachers' comments were included in the final draft as "tips from teachers" on specific lessons.

BSCS NIH3 Module: Your Ear: A Sensitive, Rapid, but Fragile Sound Processor
Final Evaluation Report
May 2001

INTRODUCTION

This final evaluation report analyzes current field test evaluation data on the NIH3 sponsored *Your Ear* module developed and implemented by BSCS in Colorado Springs. This module, *Your Ear: A Sensitive, Rapid, but Fragile Sound Processor (Hearing)*, was developed under a contract from the National Institutes of Health National Institute on Deafness and other Communication Disorders. It was nationally field tested in Maryland, Michigan and Washington from February 2001 through May 2001. The data for this final report was generated from all three sites. There were four types of data collected: 1) pre-post module tests; 2) student surveys; 3) teacher surveys; 4) classroom observations.

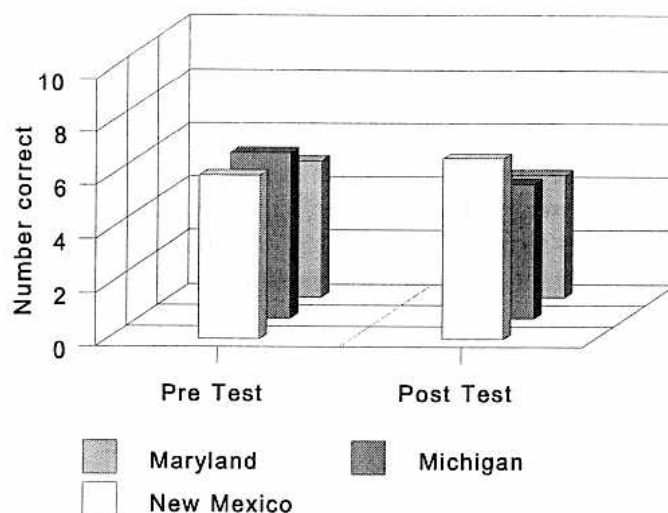
The first data item consisted of two 10 item multiple choice and short answer test items (i.e., pre- and post-tests) keyed to information distributed across the five classroom lessons (see Appendix A). After the module was completed, students were asked to fill out a two page opinion survey about the overall module and specific lessons (see Appendix B for this form). The teacher surveys provided an opportunity for feedback on specific activities (see Appendix C for this form). Teachers were also encouraged to write their observations directly in the margins of the Field Test Notebook. Classroom observations were made by BSCS staff. Appendix D contains the verbatim comments of the students from the two page opinion survey and Appendix E contains the teacher narrative comments from the field test sites.



RESULTS

In Figure 1 the pre-post test averages are plotted for each of the three field test locations.

Figure 1
Pre vs Post Hearing Test Means



Each state pre-post test difference was tested using a paired t-test procedure and two of the three mean comparisons were statistically significant at the .05 alpha level. Table 1 below gives the actual means.

Table 1
Hearing Pre-Post Test Means

		Pre Test Means	Post Test Means
Maryland	(N=25)	5.08	4.56
Washington*	(N=78)	6.17	5.01
New Mexico*	(N=49)	6.1	6.73

*Statistically significant; $p < .05$

The Student Survey form (Appendix B) contained three objective questions and two open ended questions about the module. Surveys were completed anonymously with 25 surveys from Maryland, 78 from Washington, and 49 from New Mexico. Overall, eighty six percent of the students indicated that the *Hearing* unit was "just right". Table 2 below shows the percentage distribution for the first survey question by state.



Table 2
Hearing Overall Student Perception

	Too Easy	Just Right	Too Difficult
Washington	5.9%	88.2%	5.9%
Michigan	NA	NA	NA
Maryland	8.7%	82.6%	8.7%

The second question on the student survey was an adjective check list, where the students could select one or more adjectives to apply overall to the *Hearing* unit. Table 3 summarizes the percentages of students that applied each adjective; the sum of the percentages for each field test site exceed hundred percent because students may select more than one adjective.

Table 3
Adjective Check List by State

	Fun	Confusing	Active	Stimulating	Challenging
WA	37%	22%	28%	28%	22%
MI	NA	NA	NA	NA	NA
MD	39%	61%	44%	44%	57%

The final part of the quantitative student survey questions focused on the rated *clarity* and *engagement* of the five lessons in the *Hearing* module. Tables 4 and 5 present the overall percentage distributions for these five lessons. Figures 2 and 3 show the site-by-site means on a four-point scale, where 4 indicates high clarity or engagement, and 1 indicates low clarity or engagement.

Table 4
Clarity Distribution for Five Chapters

	High	Medium High	Medium Low	Low
1. Getting the Message	30.4%	55.1%	13%	1.4%
WA	32.6%	60.9%	6.5%	0%
MI	NA	NA	NA	NA
MD	26.1%	43.5%	26.1%	4.3%
2. Sound Communication	35.3%	45.6%	19.1%	0%
WA	33.3%	53.3%	13.3%	0%
MI	NA	NA	NA	NA
MD	NA	30.4%	30.4%	0%
	39.1%			



	High	Medium High	Medium Low	Low
3. Do You Hear What I Hear	25.7%	52.9%	17.1%	4.3%
WA	34%	44.7%	19.1%	2.1%
MI	NA	NA	NA	NA
MD	8.7%	69.6%	13%	8.7%
4. A Black Box Problem: How Do I Hear?	32.4%	39.7%	23.5%	4.4%
WA	28.9%	46.7%	20%	4.4%
MI	NA	NA	NA	NA
MD	39.1%	26.1%	30.4%	4.3%
5. Too Loud, Too Close, Too Long	31.4%	45.7%	15.7%	7.1%
WA	38.3%	46.8%	12.8%	2.1%
MI	NA	NA	NA	NA
MD	17.4%	43.5%	17.4%	17.4%

Table 5
Engagement Distribution for Five Chapters

	High	Medium High	Medium Low	Low
1. Getting the Message	37.7%	33.3%	24.6%	4.3%
WA	43.5%	30.4%	23.9%	2.2%
MI	NA	NA	NA	NA
MD	26.1%	39.1%	26.1%	8.7%
2. Sound Communication	41.8%	34.3%	17.9%	6%
WA	42.2%	40%	13.3%	4.4%
MI	NA	NA	NA	NA
MD	40.9%	22.7%	27.3%	9.1%
3. Do You Hear What I Hear	39.4%	33.8%	19.7%	7%
WA	50%	35.4%	12.5%	2.1%
MI	NA	NA	NA	NA
MD	17.4%	30.4%	34.8%	17.4%

	High	Medium High	Medium Low	Low
4. A Black Box Problem: How Do I Hear?	30.9%	38.2%	22.1%	8.8%
WA	33.3%	42.2%	20%	4.4%
MI	NA	NA	NA	NA
MD	26.1%	30.4%	26.1%	17.4%
5. Too Loud, Too Close, Too Long	31%	42.3%	12.7%	14.1%
WA				
MI				
MD				

The student survey defined clarity as: *"If you felt the content and information in a lesson was 'easy to understand' give it a high clarity rating, and if you felt that the lesson was 'confusing' and 'unclear' give it a low clarity rating"*. Engagement was defined on the survey as: *"Engagement is simple. In your opinion did the lesson get you doing interesting things. If it did, give the lesson a high engagement rating, if it did not, give it a low rating"*. Figures 2 and 3 below show the site-by-site means on a four-point scale, where 4 indicates high clarity or engagement, and 1 indicates low clarity or engagement.



Figure 2

Hearing Clarity Means for Students

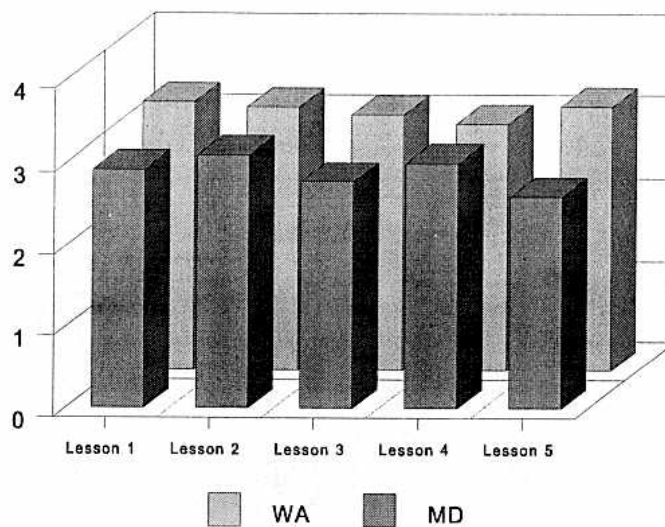
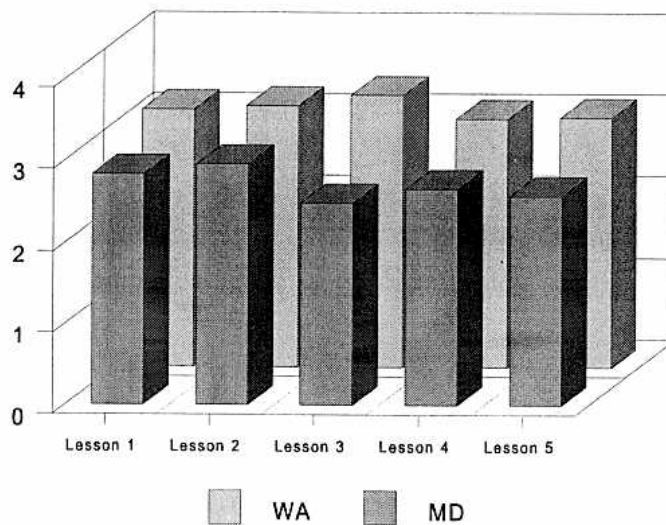


Figure 3

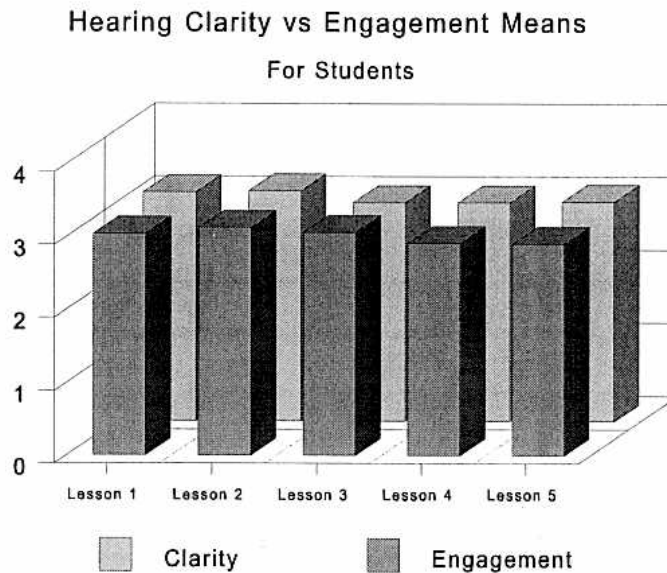
Hearing Engagement Means for Students



The final figure in this series provides a comparison of the clarity ratings and engagement ratings for each of the five lessons collapsing over the two field test sites.



Figure 4



The last part of the student survey are the written responses to two questions about what the students *liked most* and *liked least* about the lessons in the *Hearing* module. These responses will be discussed later.

Tables 6 and 7 below show the averages from the teacher survey for the three Implementation Support questions (i.e., clarity and usefulness), and the content ratings (i.e., clarity and engagement) of the five lessons from the *Hearing* module.

Table 6
Teacher Survey Implementation Support Ratings (4 point scale)

	Clarity	Usefulness
1. Organization of Lessons	4.0	3.7
2. 5E Instructional Model	4.0	3.7
3. NSES Standards	4.0	3.5

Table 7
Teacher Survey Lesson Content Ratings (4 point scale)

	Clarity	Engagement
1. Getting the Message	3.7	3.7
2. Sound Communication	3.7	3.3
3. Do You Hear What I Hear?	3.3	3.3
4. A Black Box Problem: How Do I Hear?	3.3	4.0
5. Too Loud, Too Close, Too Long	3.3	3.7

Tables 8 and 9 below show the averages from the Hearing teacher activity forms for the three questions on Teacher materials, and the five questions on Student Materials. Ratings in these tables are based on a six point Likert scale, where 6 is a strong positive rating and 1 is a low negative rating.

Table 8
Hearing Aggregated Teacher Lesson Ratings of Teacher Materials (6 point scale)

	L1A1 What did you say? n=2	L1A2 When Time is Right n=1	L1A3 Sound Safari n=1	L2A1 Up with Sound n=2	L2A2 Time Space n=2	L3A1 Measre Loudn s n=1	L3A2 Pitch Curve n=2	L4A1 Black Box n=2	L4A2 Form Fnctn n=1	L5A1 Loud Close n=2	L5A2 Assess Risk n=1	L5A3 Sound Advice n=0
Introductory sections were helpful	4.5	4	4	4.5	5	5	4.5	5	5	5	5	NA
Presentation strategies were helpful	4.5	4	3	4.5	5	5	4.5	5	5	5	5	NA



	L1A1 What did you say? n=2	L1A2 When Time is Right n=1	L1A3 Sound Safari n=1	L2A1 Up with Sound n=2	L2A2 Time Space n=2	L3A1 Measre Loudn s n=1	L3A2 Pitch Curve n=2	L4A1 Black Box n=2	L4A2 Form Fnctn n=1	L5A1 Loud Close n=2	L5A2 Assess Risk n=1	L5A3 Sound Advice n=0
Procedures for students were clear	5.5	4	4	5.5	4.5	5	4	4.5	4	5.5	5	NA

Table 9
Hearing Aggregated Teacher Lesson Ratings of Student Materials (6 point scale)

	L1A1 What did you say? n=2	L1A2 When Time is Right n=1	L1A3 Sound Safari n=1	L2A1 Up with Sound n=2	L2A2 Time Space n=2	L3A1 Measre Loudn s n=1	L3A2 Pitch Curve n=2	L4A1 Black Box n=2	L4A2 Form Fnctn n=1	L5A1 Loud Close n=2	L5A2 Assess Risk n=1	L5A3 Sound Advice n=0
Reading level appropriate for students	5.5	5	NA	6	NA	NA	5	5	5	5.5	6	NA
Conceptual level appropriate for students	3.5	5	3	4.5	5	4	3.5	4.5	5	5	5	NA
Material engaged and motivated students	4	6	3	4	4.5	4	4.5	5	6	5	5	NA
Material helped students construct understanding	5	5	3	5	5	5	4	5	6	5	5	NA
Materials for activities were worthwhile	4	6	2	5	5	4	4	5.5	5	5	5	NA

Table 10 below is designed for use by the BSCS writing team. This table organizes teacher narrative information found in Appendix E on a Lesson and Activity basis. In this way the cumulated teacher comments for a particular lesson and activity in the *Hearing* module may be easily found and thereby applied to the revision process. Table 10 is the qualitative data associated with the statistics presented in Tables 8 and 9. The **Discussion** section and



Recommendations follow Table 10.

Table 10 (Writer's Table)

Hearing Lesson 1 Activity Table		
Activity	<i>Based on your experience with this module, what aspects did you particularly like?</i>	<i>Based on your experience with this module, what aspects would you change?</i>
1	Short clips of the activities kept the attention of the students.	Students lost interest while I read the short articles. It may have been more beneficial for them to read them instead of me. Also, I could not get the sign language clip to come up on my computer.
1	Great discussions, some of my bi-lingual students try to spell that was being spoke. It was fun to hear the students first words. Parents also enjoyed that student interaction.	The activity was heavily teacher-directed. Maybe scaled back or just leave it on paper; it "looks" OK. I just felt I was doing too much leading.
2	We had easy to read stories and they were to the point. The students had tons of questions.	Are there any "modern" stories similar to the ones we used? The students wanted more.
3	It was interesting to a small number of students.	Students felt it was busy work, a stronger tie to other activities might help.

Hearing Lesson 2 Activity Table		
Activity	<i>Based on your experience with this module, what aspects did you particularly like?</i>	<i>Based on your experience with this module, what aspects would you change?</i>
1	Variety of sounds showed the students there is more than just music to listen to.	Computers I used were hard to hear. Had I headphones for each monitor, it would have been easier. It was a little difficult to grasp the "nature walk" not being able to hear it completely. I would change the instrumental music to a sample of four different kinds.
2	It made the students think about specific sounds.	Although students were engaged, it was somewhat confusing for them. They had a hard time getting a variety of sounds representing Earth. They kept adding music by different artists. Once we cleared up, they worked better.
1	Kids had a good time with soundtracks. Great discussions.	Again, this was a highly teacher-directed activity. But this is OK for many.
2	Working in groups. Group directed and student controlled outcomes.	Students in the group (present generation) struggled! They had a really hard time coming up with sounds that are of their generation.



Hearing Lesson 3 Activity Table		
Activity	<i>Based on your experience with this module, what aspects did you particularly like?</i>	<i>Based on your experience with this module, what aspects would you change?</i>
2	This show the students the relationship between pitch and loudness.	I was confused with less at first, because I was not clear on the response curve. Once I went over it a number of times, it was better. It was also difficult for students to hear the differences in their computers because each one was working at a different frequency. Again, headphones would have helped here.
1	Several students know that db is a measure of loudness, but they didn't know what it meant. It built on some prior knowledge. This lesson also provide a good pace for later discussions using db.	Concept to pitch seems to be difficult to grasp. They can give only basic examples of pitch. Yet many of those examples are modified examples of the ones I gave. Many cannot give other examples.
2	Kids liked the use of the Web.	On the Web, we could have the ability for students to change the pitch and loudness and see the visual effects. Some frequencies at zero loudness have audible tones.

Hearing Lesson 4 Activity Table		
Activity	<i>Based on your experience with this module, what aspects did you particularly like?</i>	<i>Based on your experience with this module, what aspects would you change?</i>
1	It was easier to do. They understood the sequence procedure.	I feel they could use more prior knowledge in ear anatomy.
1	Working in groups. Kids love to deal with challenges. They finally felt the previous days' information was now starting to make sense.	I feel students would have liked more depth and time spent dealing with this. They wanted to know more about hair cells, the Organ of Corti, how hairs create electrical messages.

Hearing Lesson 5 Activity Table		
Activity	<i>Based on your experience with this module, what aspects did you particularly like?</i>	<i>Based on your experience with this module, what aspects would you change?</i>
1	Quick and to the point.	The use of sound meter helped students get the concept of actual db of common sounds or activities. Without this, it's unclear to them.
2	Having students work in groups of four to do assignments kept them from talking. It was busy work. Grouping. Students controlling discussions.	Provide discussion questions for teams about each individual. It's unclear how to fill in the column "estimated db level" since the "Activities in Morning" could be several things. There was much confusion on what to write down. Each group did it differently.



	Hearing Lesson 5 Activity Table	
Activity	<i>Based on your experience with this module, what aspects did you particularly like?</i>	<i>Based on your experience with this module, what aspects would you change?</i>
3	Nice reflection on self-issues of hearing. Many students are amazed at how many times they might be causing damage.	Many students did not truly do a good job with personal sound diary, thus making this activity limited.



DISCUSSION

This section discusses patterns in the narrative data (especially from student comments) which contrast with some of the statistical patterns.

The strongest contrast occurs between the lack of pre-test to post-test gain and student narrative data. Across the three field test sites only one site showed a statistically significant *gain* from pre to post test. A second site showed a significant *decrease*, while the third site showed no change. This lack of statistical evidence contrasts with the student narrative where the positive comments constitute 60% of the record, and the negative (i.e., *liked least*) only 40%. Furthermore, as seen below students appeared to like several of the major activities within the module (e.g., “time capsule”; “coat hanger”). Furthermore several students wrote about the overall “impact” of the module:

“I liked learning in this unit. It was pretty easy but I learned lots of things about sounds and how they effect your ear. I also will be more careful about sound to help my ears.” [page D-7]

“It was a unique class; it wasn’t like it was hard; it was interesting; I learned something other than basic school stuff.” [page D-8]

While not a large percentage of students said that the *Hearing* module was easy (in fact, there are a number of comments about what was confusing), some students found the module “easy”. The significance of this observation is that the pre-test scores were generally higher than the pre-test scores on the other two NIH3 modules (i.e., Alcohol and Sleep). Furthermore, it was noticed that the second question on the post test was often incorrect, asking for three *characteristics* of sound. Instead of pitch, timing and loudness, students often wrote *outer ear*, *middle ear* and *inner ear*. The evaluator’s observation is that the word *characteristic* may have been misunderstood by the students. These students got the answer incorrect though manifesting something learned from the module. On other modules a “one-item” test score difference was statistically significant. While additional analyses would need to be done to confirm this observation, it is worth noting in view of the student narrative comments. Finally, the pattern of statistics while slightly “lower” than the other two NIH3 modules, do not seem to be “strongly lower” like the pre-post test comparisons.

Table 2 indicates that student perception of the *Hearing* module was that it was neither “too easy” nor “too difficult” (i.e., 86.5% saying “just right”). Furthermore the balance on either side of “just right” is even. A major “negative” statistic appears in Table 3, with 61% of the students at one field test site indicating that the module was “confusing”. Examination of the student narrative indicates that for a number of students the sounds emitted from the computer were difficult to hear, creating a confusing activity.

“Computers I used were hard to hear. Had I headphones for each monitor, it would have been easier.” [teacher comment; page E-1]

“I liked least the “Do You Hear What I Hear?” lesson because I



couldn't understand it." [page D-2]

Another area of confusion has to do with the nature of sound itself. Characteristics of sound are different than characteristics of visual activities. Identifying pitch is qualitatively different than identifying color. It appears that this difference may be the source of some confusion for the students:

"Writing down the sounds of our environment was kind of confusing and hard. I didn't really understand what kind of sounds we were writing down until the end." [page D-5]

As in other NIH3 modules the level of "engagement" across the five lessons was lower than the level of "clarity" (Figure 4). However, the level of clarity across the five lessons was generally lower than the Alcohol and Sleep modules.

Despite the fact that some of the statistical indicators were lower for *Hearing* relative to the Alcohol and Sleep modules, from the students' perspective there were a number of very successful activities. Table 11 below summarizes the approximate distribution of positive comments, and distribution of negative comments (i.e., liked least) across the five lessons.

Table 11
Distribution of Student Narrative Comments

	Percent of Total Positive Comments	Percent of Total Negative Comments
1. Getting the Message	4%	16%
2. Sound Communication	27%	3%
3. Do You Hear What I Hear?	18%	25%
4. Black Box Problem	38%	31%
5. Too Loud, Too Close, Too Long	13%	25%

The first lesson "Getting the Message" was the least active and the least popular lesson based on the student narrative. "Sound Communication" was the strongest lesson overall. It emerged as the strongest from the students' perspective because of the *interactivity*.

"The thing I liked most was when we made the time capsules about sound. I liked it most because that was the only time we got to do something fun in groups." [page D-2]



The importance of interactivity came up a number of times in the student narrative. Only one student did not like this interactivity, while for the others that mentioned interactivity, it was a positive aspect of the module.

The lesson which got the highest percentage of positive remarks was lesson four (Black Box Problem).

"The one I liked most was 'A Black Box Problem: How Do I Hear?'. The reason why was because I like challenging things and it was mostly easy." [page D-3]

On the other hand, the highest percentage of negative remarks was also associated with lesson four. It appears that some students objected to the demanding nature of this lesson.

"What I liked least was when we had to put the cards in order because it was too hard to put them in order." [page D-4]

Also, within lesson four was the "coat hanger activity", which clearly was the most salient activity to the students. It got mentioned frequently and with specificity.

"I liked the hanger because it was very educational." [page D-1]

"One of the activities I liked the most was the war with the hangers. We used a loose hanger and a long piece of string tied to the hanger." [page D-2]

"... Also I like the hanger activity when you put the string with the hanger and you hit something." [page D-2]

The nature of examining sound may have confused some students, and the pre/post tests may have been too easy with an aberrant question on the post-test. Nonetheless the *Hearing* module showed impact in terms of the specificity of the student comments as well as the saliency of some of the activities. Also, the student narrative were particularly revealing from an educational standpoint. That is, the nature of sound appeared intrinsically confusing, activities that were particularly active (e.g., involving banging) were quite salient, and some activities such as the Black Box puzzle got mixed reviews. In some cases students liked the challenge of the Black Box, and in other instances students were frustrated by the challenging nature of the Black Box.



RECOMMENDATIONS

1. Adjust the “challenge-level” of the Black Box activity so that more students are successful;
2. Brainstorm new ways to present “sound” to students, perhaps using more analogies to familiar qualities like color, and/or using natural group differences in ability to hear pitch and other sound qualities in order to better illustrate for the rest of the class qualities of sound (the later part of this recommendation would also add more interactivity);
3. Rewrite the pre and post tests;
4. Examine lesson 1 with an effort to make the opening lesson more engaging to students;
5. Develop alternate ways for delivering “sound comparisons” that do not rely completely on computer speakers;
6. Retain interactive aspects of “Time Capsule” and other interactive activities;
7. Examine distribution of time across some of the activities (e.g., more time for lesson 4, perhaps less time for lesson 1);
8. Reduce the “teacher-directedness” of selected activities (e.g., L2A1);
9. Retain the overall emphasis and content of current lessons (i.e., major overhaul of module is not warranted).

